

AMMONIA CONTENT IN THE VENUS ATMOSPHERE ACCORDING TO DATA FROM
THE VENERA-8 PLANETARY PROBE

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Translation of: "O Soderzhanii Ammiaka
v Atmosfere Venery po Dannym Avtomati-
cheskoy Stantsii "Venera-8." In: Doklady
Academy of Sciences USSR, Vol. 213, No.
2, Nov. 11, 1973, pp. 296-299.

(NASA-TT-P-15544) AMMONIA CONTENT IN THE
VENUS ATMOSPHERE ACCORDING TO DATA FROM
THE VENERA-8 PLANETARY PROBE (Linguistic
Systems, Inc., Cambridge, Mass.) 8 p HC
\$4.00

N74-23373

Unclass

CSCL 03B G3/30 38836



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

MAY, 1974

STANDARD TITLE PAGE

1. Report No. NASA TT F-15,544	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Ammonia Content in the Venus Atmosphere According to Data from the Venera-8 Planetary Probe.		5. Report Date May, 1974	
7. Author(s) Yu. A. Surkov B. M. Andreychikov O. M. Kalinkina		6. Performing Organization Code	
9. Performing Organization Name and Address LINGUISTIC SYSTEMS, INC. 116 AUSTIN STREET CAMBRIDGE, MASSACHUSETTS 02139		8. Performing Organization Report No.	
12. Sponsoring Agency Name and Address NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WASHINGTON, D.C. 20546		10. Work Unit No.	
		11. Contract or Grant No. NASW-2482	
		13. Type of Report & Period Covered TRANSLATION	
		14. Sponsoring Agency Code	
15. Supplementary Notes Translation of: "O Soderzhanii Ammiaka v Atmosfere Venery po Dannym Avtomaticheskoy Stantsii "Venera-8." Doklady Academy of Sciences USSR, Vol. 213, No. 2, Nov. 11, 1973, pp. 296-299.			
16. Abstract An instrument to measure the ammonia content in the Venus atmosphere is described. It was carried by the Venera-8 planetary probe during its Venus landing in July 1972. The instrument is based on a differential linearly-colorimetric method. The color change of the bromphenol blue in calcined (dehydrated) silica gel when exposed to an ammonia-containing atmosphere is compared to it under certain standard conditions. The measurements were conducted at two levels (about 2 and 8 atmospheres). On the basis of these measurements, the volumetric content of the ammonia in the Venus atmosphere is estimated to be 0.01 to 0.1%.			
17. Key Words (Selected by Author(s))		18. Distribution Statement UNCLASSIFIED - UNLIMITED	
19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages 8	22. Price 4.00

Ammonia Content in the Venus Atmosphere According to Data
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(presented by Academician A. P. Vinogradov, 11/20/72)

Previously we published [1-4] the results of a study of the ^{1296*} composition of the atmosphere of Venus which were obtained by means of a gas-analyzing device which was installed on the planetary probes, Venera-4, -5, and -6." The data from these measurements showed that carbonic acid gas is the chief component of the atmosphere and that its content amounts to 97%. Nitrogen is present in an amount not exceeding 2%, oxygen--0.1%, and water vapor in relatively large amounts only in the upper layers of the atmosphere.

Meanwhile, despite the creation of completely definite concepts of the composition and structure of the atmosphere, the problem of the cloud layer of Venus remained unsolved. In some works [5-8] clouds of the water type are suggested as the basic component, while other authors [9-12] do not consider them the chief component of the dense cloud cover of Venus. In addition, some results [13-16] of measurements in the atmosphere of the planet indicate a possible phase transition on the level of pressures of 1-2 atm, which does not agree with a water model of the cloud layer.

*Numbers in the margin indicate pagination in the foreign text.

Input of atmosphere
to be tested

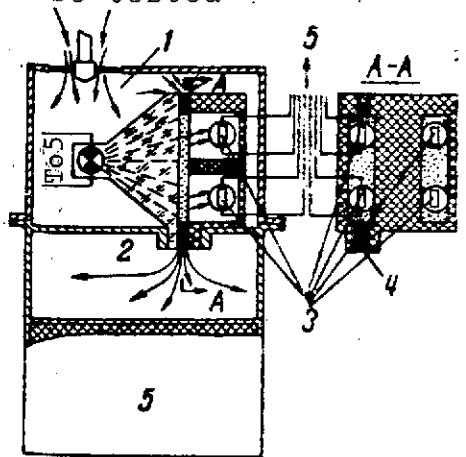


Fig.1. Schematic diagram of the operation of the ammonia meter: 1-measurement chamber; 2-calibrated volume; 3-photoresistors; 4-filter; 5-electronic unit.

ation of free nitrogen. But with a small amount of O_2 and an abundance of CO_2 in the atmosphere of Venus, the presence of nitrogen partially in a bound state in the form of ammonia may be expected. Therefore, an experiment was set up on the planetary probe "Venera-8" to determine the ammonia content in the atmosphere of Venus.

As is known, "Venera-8" in July 1972 reached the surface of the planet, after having completed a smooth descent in its atmosphere. The goal of the launching of the "Venera-8" probe to obtain data on the character of the soil composing the surface of Venus, and also to study the physical-chemical characteristics of the atmosphere on the light side of the planet and, in particular, to determine the ammonia content.

The peculiarity of the physical-chemical characteristics of the atmosphere of Venus allows the supposition that the geochemical evolution of some of its components must differ from the components of the earth's atmosphere. In this regard, the evolution of nitrogen in the atmosphere of Venus is of definite interest. The source of nitrogen--ammonia--probably as on earth, was degasified as a result of volcanic activity. On the earth NH_3 was oxidized by photosynthetic oxygen with the formation of free nitrogen.

In order to measure the ammonia, an instrument was set up on the probe based on a differential linearly-colorimetric method of determination, i.e., the registration of change in color of a

chemical agent with the action of ammonia on it. Bromphenol blue in calcined silica gel was used as such an indicator. The principle of operation of the instrument is shown in Fig. 1. The instrument was a vacuum-action system, consisting of two chambers--the measurement chamber, 1, and the calibration chamber, 2. In the measurement chamber a transparent cuvette with an ammonia absorbent was installed, which had contact with a light guide and a block of detectors; the cuvette has two sections--an operational and a calibrating section--which were filled with indicator powder. The calibrating section of the cuvette was hermetically sealed off from the operational section and the outside atmosphere. The operational section is joined to a vacuum-action calibration vessel. The light source through the light guide ensured even lighting of the cuvette. The light, partially absorbing, passed through a thin layer of a chemical agent and was taken up by photoresistors, 3, one of which was in contact with the operational section of the cuvette, the other, with the calibration section.

On command of the programmed-time device of the station, the instrument became unsealed, and the atmosphere entered through the operational section of the cuvette into the calibration vessel. During the descent of the station, the instrument was opened and the gas passed constantly, under the influence of external pressure, through the operational section of the cuvette, where the measurement of the ammonia took place.

The instrument set up on the "Venera-8" probe made measurements on two levels at a pressure of ~ 2 atm and ~ 8 atm. Both readings of the instrument correspond well, and the volumetric content of the gas in the measurement sector may be estimated to be 0.01-0.1%.

As was pointed out above, we used as an indicator bromphenol blue in calcined (dehydrated) silica gel. Under the conditions of

the atmosphere of Venus, it is sufficiently selective as an indicator for ammonia. Nevertheless it must be noted that the results obtained may mask the presence of alkali vapors. But neither the data of direct and spectroscopic measurements of the composition of the atmosphere of Venus [17] nor the observed balances of the system of the atmosphere-lithosphere under the parameters of the atmosphere of Venus which were close to those measured with the aid of the apparatus of the "Venera-8" probe [18], indicate the possibility of the presence in the atmosphere of the planet of any other components which give alkaline reactions. Thus the results which we obtained with the aid of the instrument of the "Venera-8" probe must be due to the presence of ammonia in the atmosphere of the planet.

The data available allow some suppositions to be made on the structure and chemical composition of the cloud layer of Venus. As is known, ammonia easily combines with carbonic acid gas and water vapor, forming a whole series of compounds (carbonate, bicarbonate, carbamate of ammonia, etc.). These are white crystalline substances which are easily soluble in water and are volatilized when the temperature rises. The quantities of ammonia which we measured show that similar compounds in the atmosphere of Venus must be formed at a temperature of 270-280° and lower. In addition, the lower border of such a cloud layer (level of decomposition of ammonia compounds) must be rather sharp, and the ammonia content near to its maximum.

Insignificant amounts of fluoride and chloride of ammonia may enter into the composition of the ammonia clouds. In addition, chloride of ammonia under the conditions of the atmosphere of Venus decomposes under a pressure of ~ 10 atm. Ammonia clouds of such a type must be multilayered. The lower level of the clouds should consist primarily of ammonium chloride, possess a low density, and be located at a pressure level of ~ 10 atm.

The second layer must be located on a level where the pressure 7298 constitutes 10^{-2} atm. Here the primary composition of the particles are carbonates of ammonia. Finally, depending on the relationship of water vapors and ammonia above this level, the existence of ice crystals is not excluded.

Near the lower edge of the ammonia clouds a precipitation of ammonia salts, their subsequent disintegration, and the diffusion of water vapor and ammonia upward are possible. Clouds of the ammonia type have only a very small amount of liquid water, if any. Probably here the washing action of the rains is insignificant, and, consequently, the presence in the cloud layer of Venus of particles of mineral dust is possible. It is known, for example, that volcanic dust on the earth rises to an altitude of 60 km.

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